Fortier LM, Popovsky D, Durci MM, Norwood H, Sherman WF, Kaye AD. An Updated Review of Femoroacetabular Impingement Syndrome. *Orthopedic Reviews*. 2022;14(3). doi:10.52965/001c.37513

General

An Updated Review of Femoroacetabular Impingement Syndrome

Luc M Fortier[1] [a], Daniel Popovsky[1], Maggie M Durci[2], Haley Norwood[2], William F Sherman[3], Alan D Kaye[4]

[1] Georgetown University School of Medicine, [2] Louisiana State University Shreveport School of Medicine, [3] Department of Orthopaedic Surgery, Tulane University, [4] Department of Anesthesiology, Louisiana State University Health Shreveport

Keywords: femoroacetabular impingement, hip, cam lesion, pincer lesion, labrum

https://doi.org/10.52965/001c.37513

Orthopedic Reviews

Vol. 14, Issue 3, 2022

Femoroacetabular impingement (FAI) is a chronic hip condition caused by femoral head and acetabular malformations resulting in abnormal contact across the joint. FAI often leads to labral, cartilaginous, and tissue damage that predispose this patient population to early osteoarthritis (OA). There are a variety of factors that increase the risk for FAI including younger age, Caucasian background, familial FAIS morphology, and competing in high-intensity sports during adolescence. Slow-onset, persistent groin pain is the most frequent initial presenting symptom. On physical examination, patients will typically have a positive FADIR test (flexion, adduction, internal rotation), also known as a positive impingement sign. FAI syndrome can be organized into three classifications; cam, pincer, or mixed. This classification refers to the characteristic morphological changes of the bony structures. The primary imaging modality for diagnosing FAI is a plain radiograph of the pelvis, which can be used to measure the alpha angle and the lateral center edge angle used to quantify severity. Conservative treatment is typically considered first-line treatment for mild to moderate FAI syndrome; however, the outcomes following postoperative surgical intervention have demonstrated excellent results. The most common surgical treatment option for FAI is done arthroscopically.

INTRODUCTION

Femoroacetabular impingement (FAI) is a chronic hip condition caused by femoral head and acetabular malformations resulting in irregular forces and contact across the joint and bones. FAI often leads to labral, cartilaginous, and tissue damage that predispose this patient population to early osteoarthritis (OA).[1,2] FAI was defined by Ganz et al.[3] and Sankar et al.,[4] but it was not until 2016 that a consensus regarding the proper diagnosis of FAI *syndrome* (FAIS) was established.[5] FAIS consists of a triad of specific symptoms, clinical signs, and particular bony deformities. The symptoms include hip/groin pain aggravated by activity or sitting, commonly with referral to the buttocks, thighs, or knees. Patients also frequently report "clicking, catching, locking, stiffness."[6] Patient often present with decreased range of motion (ROM), especially flexion and internal rotation, and positive impingement tests (i.e., Flexion Abduction External Rotation (FABER) and Flexion Adduction Internal Rotation (FADIR)).[1,6] Anterior-posterior (AP) radiographs are used to identify the specific osseous changes and rule out other origins of hip pain.[5,7] The FAIS morphologies can be divided into cam, pincer, or mixed. Cam deformity is from decreased head-neck offset or an abnormally shaped femoral head, with convexities and bony deposition occurring at the head-neck junction, most commonly in the anterosuperior region.[6,8] Pincer deformity describes excess coverage of the acetabulum over the femoral head, which can be secondary to coxa profunda or acetabular retroversion.[1,9] Severity is measured with two calculated angles: the alpha (α) and lateral central-edge angles (LCEA) for cam and pincer lesions, respectively. A combination of both cam and pincer deformities, referred to as mixed, is the most common presentation. Management consists of conservative therapy (activity modification, oral medications, physical therapy) or surgical options, with the latter reserved for patients that fail conservative treatment or present initially with severe symptoms.[6]

[a] **Corresponding author:**
Luc M. Fortier
Georgetown University School of Medicine
3900 Reservoir Road NW
Washington, DC 20007
Phone: (310) 254-6534
Lmf82@georgetown.edu

EPIDEMIOLOGY

FAIS epidemiology is challenging to quantify because current studies either lack power, use differing radiographic criteria, or do not adhere to the diagnostic triad when examining populations.[1,6,10] Nonetheless, recent studies have examined FAIS incidence in specific populations. For instance, younger athletes, or those participating in high-intensity sports such as soccer, hockey, basketball, and football, have higher rates of FAIS and OA.[1,6,11–13] In fact, studies have demonstrated that cam morphology can be two to eight times more common in athletes as compared to the general population. The α angle used to quantify cam lesions is reported to be significantly higher in male athletes.[1,11–13] One review reported asymptomatic cam deformities in 37% of over 2,000 young hips. Of those cam deformities, 54.8% were athletes as compared to 23.1% non-athletes.[14] On the other hand, the relationship between pincer morphology and athletic activity is less defined.[6] In another study, the incidence of FAI was 54.4 per 100,000, with 73% of hips having mixed morphology.[15] This is consistent with other studies that report mixed as the most common morphology overall.[1,6,13,14,16]

RISK FACTORS

There are a variety of factors that increase the risk for FAI and ultimately FAIS. This includes younger age, Caucasian background, familial FAIS morphology, and competing in high-intensity sports during adolescence.[1,13,15] Sport participation during skeletal immaturity may lead to femoral neck deformities with resultant increases in α angle and cam lesion prevalence.[1,17] Agricola et al found that Caucasians possess specific hip anatomy that predispose to FAI versus other backgrounds.[17]

Any pathology that distorts normal hip anatomy such as Legg-Calvé-Perthes disease (LCPD), slipped capital femoral epiphysis (SCFE), or developmental dysplasia of the hip (DDH) can also increase the risk. SCFE and LCPD result in femoral head/neck malformation secondary to epiphyseal slippage or physis remodeling from ischemia, respectively. Inherent acetabular deformation from DDH causes the femoral head to make abnormal contact with the acetabulum.[18–24]

FAIS in general predisposes patients to develop musculoskeletal injuries and progressive OA. For instance, a study found that patients with cam lesions and an α angle >60˚ are more likely to experience progression of their OA.[6,16] In addition, FAIS may increase hamstring tendon tension and abnormal pelvic tilt which increases the risk of hamstring tendon injury.[25,26]

PATHOPHYSIOLOGY

Femoroacetabular impingement syndrome (FAIS) is an increasingly common cause of hip pain that has been commonly identified in young adult athletic populations.[27] The source of pathology lies at the acetabulofemoral joint, a ball-and-socket joint that houses the articulation between the femoral head and the acetabulum of the hip. The femoroacetabular joint contains an acetabular labrum, which provides depth to the joint and constrains its movement, as well as cartilaginous structures that enhance stability during movement. A fibrous capsule surrounds the joint and the intraarticular components. The thickening of this capsule helps form the ligaments that provide increased stability to the hip. The arterial supply is provided primarily by the medial and lateral circumflex femoral arteries, and it is innervated by branches from the femoral, sciatic, and obturator nerves.

Abnormal bony morphologies of the femur and the acetabulum can result in impingement that present clinically as pain with repetitive movements. Extra bone growth during development such as anomalous bone spur formation along the acetabulum and/or proximal femur can result in abnormal bony anatomy. As a result, the normal physiological articulation between the constituent bones of the hip joint is disrupted, causing impingement and concomitant pain.[28] Over an extended period of time, the friction and stress generated by abnormal articulation may lead to damage of the labrum, erosion of joint depth, deterioration of the fibrous capsule, and resultant instability. If left untreated, the extensive and cumulative damage eventually leads to early manifestations of osteoarthritis within the hip joint.[29] However, due to extensive individual variability in presentation, it has been challenging in practice to define and specify the abnormal radiographic and clinical femoroacetabular morphology that causes FAI.[30] Notwithstanding, it is possible for excessive movement and supraphysiologic hip range of motion to cause impingement without any underlying morphological abnormalities.[30]

CLINICAL PRESENTATION

FAI predominantly presents in physically active young adults. The excessive friction between the femoral head and acetabulum over time commonly manifests as slow-onset, persistent groin pain.[31] In clinic, this is the most frequent initial presenting symptom for patients with FAI.[29] The pain is typically described as intermittent and aggravated by minor trauma, prolonged physical exercise, participation in a sporting event, or long periods of ambulation. Additionally, pressure on the joint itself such as extended periods of time spent in a seated or resting position may precipitate pain.[31] In a study conducted by Phillippons et. al, 60% of patients developed symptoms after a period of active sports participation, whereas only 24% reported insidious symptom onset as a result of traumatic injury.[32]

Due to the nonspecific clinical signs and symptoms of presenting hip pain, it is common for patients to undergo numerous screening tests and additional diagnostic workup. On physical examination, patients with FAI will typically have a positive FADIR test, also known as a positive impingement sign.[32] This exam is performed with the patient lying supine as the clinician flexes the leg 90 degrees, adducts the entire leg across the patient's midline, and abducts the calf and foot while maintaining the knee in

position. A positive test is elicited if the patient endorses hip pain during the final step. Patients with FAI will oftentimes exhibit a positive FABER test as well. In this maneuver, the patient lies supine while the affected leg is flexed, abducted, and externally rotated. While the examiner stabilizes the contralateral pelvis, downward force is exerted on the affected leg. The test is positive if the knee of the affected leg is raised as a result of the downward force. Nevertheless, due to variability in patient presentation and underlying physiology, there exists no consensus on objective guidelines or specific diagnostic criteria to reliably diagnose FAI syndrome.

DIAGNOSIS

CLASSIFICATION

FAI syndrome can be organized into two different classifications, each being defined by the unique and characteristic morphological changes of the bony structures. The first type, known as a cam impingement, describes an abnormality in the shape of the proximal femur.[28] A normal femoral head is spherical, facilitating smooth rotation within the femoroacetabular joint and allowing unobstructed movement of the ball-and-socket articulation. A cam impingement, on the other hand, results in excessive shear forces on the articular cartilage lining the acetabular rim adjacent to the labrum. Consequently, damage to this cartilage will cause detachment of the labrum that helps to provide depth of the hip joint.[28] The most common movements of the hip that are restricted by cam lesions include flexion, internal rotation, and adduction.[30]

The second major classification of FAI syndrome is known as a pincer lesion. A pincer lesion is defined as excess bone formation at the acetabular rim rather than the proximal femur itself. This bone growth leads to excessive overlap around the femoral head. As a result, similarly to cam impingement, the morphological change to the femoroacetabular joint creates abnormal articulation. Pincer lesions lead to direct impingement of the acetabular labrum itself, unlike cam lesions which primarily disrupt the chondral surface of acetabular rim. Therefore, pincer lesions are less likely to demonstrate damage to the acetabular articular cartilage on radiographic examination.[28,30]

A combination or mix of both cam and pincer lesions is the final classification of FAI impingement. Excess bone formation on the acetabular rim and the proximal femur frequently damage both the acetabular rim cartilage and the labrum to varying degrees. Patients with mixed FAI morphology will often have a worse clinical prognosis as compared to cam or pincer lesions alone.

The demographics of those with cam and pincer impingement are often different. For example, cam lesions tend to occur more frequently in young athletic males, whereas pincer lesions are detected more often in physically active middle-aged females.[31] However, while both pincer and cam impingement often have distinctive clinical presentations, the radiographic findings are difficult to predict and can be complex, necessitating thorough interpretation by an expert.

IMAGING

The primary imaging modality for diagnosing FAI is a plain radiograph of the pelvis. Specifically, an anterior-posterior (AP) and lateral view are customarily ordered together.[33] Both radiographic views are preferred to avoid the risk of missing a cam impingement that may be difficult to diagnose on an AP view.[34] When plain radiographs are not definitive, magnetic resonance imaging (MRI) is frequently ordered to help identify specific trauma to the acetabular cartilage or the labrum.[35] However, due to the paucity of defined and empirically verified imaging guidelines to diagnose FAI syndrome, the sensitivity and specificity for these imaging modalities are unknown.

Specific characteristic angles around the joint are measured on radiographs to help diagnose cam and pincer lesions. Cam impingement is defined by the alpha angle, which is measured by drawing a circle around the borders of the femoral head. A line is drawn from the center of the circle distally through the middle of the femoral neck, while a second line is drawn from the center of the circle to the location where the femoral head exits the circle. The angle between these two lines is reported as the alpha angle. As a result, a femoral head with a wider border will exhibit a greater alpha angle. Experts suggest an alpha angle greater than 60 degrees should be used as a firm criteria to diagnose a cam lesion.[36] On the other hand, a pincer lesion is defined by the lateral center edge angle (LCEA). To ascertain the LCEA, a line is drawn along the vertical center axis of the femoral head, while another line is drawn from the center of the femoral head to the bordering acetabular rim that is covering the femoral head. The angle between these two lines is the LCEA. An angle greater than 40 is a diagnostic c used to classify and diagnose pincer lesions.[37]

TREATMENT

CONSERVATIVE TREATMENT

Conservative treatment is typically considered first-line treatment for mild to moderate FAI syndrome as it can provide marked symptomatic relief.[38] Conservative therapy consists of an intensive, long term physical therapy program specified toward the individual's symptoms.[39,40] According to a meta-analysis published in 2020 that analyzed physical therapy as an early treatment option for FAI, specific exercises tailored to each individual is important for successful outcomes. This study also reported that an active routine focused on building core muscles is associated with an increase in effectiveness as compared to an alternative routine without core strengthening.[41]

However, conservative therapy should not be the first treatment option for all patients. Instead, the type of morphology may help guide the decision-making process. For instance, evidence has demonstrated that patients with a cam deformity have worse outcomes from conservative treatment as compared to other types of FAI syndrome.[42]

While conservative therapy can relieve symptoms in carefully selected patients, it is not significantly helpful in most patients with FAI syndrome. Even with long-term

physical therapy regimens, the outcomes following postoperative intervention remain significantly better than physical therapy alone.[42]

SURGICAL TREATMENT

The goal of FAI surgery is to re-establish the normal relationships between the components of the hip joint to restore normal function.[43] Diagnostic imaging is the most useful criterion to determine if surgery is indicated. Additional criteria include subjective symptoms, clinical signs, and the failure of conservative therapy.[44] Nonetheless, FAI syndrome may not always respond to surgery. Some common causes of failure to respond postoperatively include persisting bony deformities and an inadequate capsular closure.[45]

The most common surgical treatment option for FAI is addressed arthroscopically. An increased understanding of the importance of chondrolabral preservation and associated labral repair has since increased the effectiveness of arthroscopic surgical repair of FAI syndrome. Additionally, recent literature regarding capsular closure after hip arthroscopy has shown to improve postoperative outcomes. The most important ligament to repair in a capsular closure is the iliofemoral ligament as it is necessary for the long-term stability of the hip while also ensuring an appropriate range of motion. The iliofemoral ligament is difficult to avoid disrupting during surgery because both the interportal and T-capsulotomy techniques result in direct injury to the ligament.[46] These approaches are particularly favorable for athletes as it results in a higher likelihood of returning to sport with a low risk for complications as compared to other capsulotomy techniques.[39] On the contrary, while the arthroscopic repair of FAI and labral associated injuries have been proven successful in young adults, the outcomes are inconsistent in older populations.[47] However, in general, arthroscopic surgical approach has been proven to be a superior treatment option over conservative treatment in those who can undergo a surgery.[48]

Aside from hip arthroscopy, there exists other less common surgical treatment options. Historically, open surgical treatment of FAI was common as it allowed for the greatest visualization and ability to easily reach the femoral head, the labrum, and the acetabulum. An open surgical approach remains helpful for particularly difficult cases of FAI syndrome that require more access to the joint than arthroscopy alone can provide. This is commonly seen in patients presenting large and/or complex cam or pincer deformities.[49] It is also commonly used for revision surgeries initially performed with arthroscopy due to inadequacy of arthroscopy to access the deformity.[50]

Another less commonly used technique is an anterolateral approach, also known as the Watson-Jones technique, which is used primarily for anterolateral deformities. The benefit of this technique is that it provides direct access to anterior lesions while preserving the blood supply to the femoral head.[51] In addition, another less common surgical approach is the combined mini-open with arthroscopy. This technique avoids dislocating the hip while still addressing FAI malformation. However, although it is less invasive than an open approach, this combined technique can only treat cam-type lesions because the acetabulum cannot be accessed accurately without dislocation.[52]

CONCLUSION

Femoroacetabular Impingement Syndrome is an increasingly common hip disorder in adolescents and young adults that results in hip pain and reduced ROM. The syndrome is diagnosed based on clinical signs (positive impingement signs, decreased ROM), symptoms (hip/groin pain), and specific deformities on imaging. Common diagnostic imaging includes AP and lateral views of the pelvis and hip. Calculation of the α and LCEA angles can help categorize the severity of an individual's morphology. MRI can be used to further delineate labral and chondral injuries, while also ruling out other causes of hip pain. While all three morphologies are prevalent in the general, asymptomatic population, increased athletic training with repetitive force has been associated with aberrant bone growth. This specifically places athletes at a higher risk for development of cam-type deformities. Treatment includes activity modification, NSAIDs, physical therapy, as well as surgical intervention. Initial treatment is guided by a patient's personal goals and should be tailored to the severity of symptoms. Physical therapy focuses on hip/core flexibility and strengthening exercises. One study noted 82% improvement in symptoms in a cohort of 93 adolescent FAI hips after 2 years of conservative therapy.[6] Early recognition of this condition allows for improved quality of life and may prevent the progression of OA in susceptible patients. It is important for clinicians to be aware of FAI and its clinical presentation in order to provide the best care possible and improve outcomes in this patient population.

REFERENCES

1. Egger AC, Frangiamore S, Rosneck J. Femoroacetabular Impingement: A Review. *Sports Medicine and Arthroscopy Review*. 2016;24(4):e53-e58. doi:10.1097/jsa.0000000000000126

2. Menge TJ, Truex NW. Femoroacetabular impingement: a common cause of hip pain. *Physician and Sportsmedicine*. 2018;46(2):139-144. doi:10.1080/00913847.2018.1436844

3. Ganz R, Parvizi J, Beck M, Leunig M, Nötzli H, Siebenrock KA. Femoroacetabular Impingement: A Cause for Osteoarthritis of the Hip. *Clinical Orthopaedics and Related Research*. 2003;417:112-120. doi:10.1097/01.blo.0000096804.78689.c2

4. Sankar WN, Nevitt M, Parvizi J, Felson DT, Agricola R, Leunig M. Femoroacetabular impingement: Defining the condition and its role in the pathophysiology of osteoarthritis. *Journal of the American Academy of Orthopaedic Surgeons*. 2013;21(suppl):S7-S15. doi:10.5435/jaaos-21-07-s7

5. Griffin DR, Dickenson EJ, O'Donnell J, et al. The Warwick Agreement on femoroacetabular impingement syndrome (FAI syndrome): An international consensus statement. *Br J Sports Med*. 2016;50(19):1169-1176. doi:10.1136/bjsports-2016-096743

6. Trigg SD, Schroeder JD, Hulsopple C. Femoroacetabular Impingement Syndrome. *Curr Sports Med Rep*. 2020;19(9):360-366. doi:10.1249/jsr.0000000000000748

7. Zhang S xing, An M yang, li Z li, et al. Arthroscopic Treatment for Femoroacetabular Impingement Syndrome with External Snapping Hip: A Comparison Study of Matched Case Series. *Orthop Surg*. 2021;13(4):1730-1738. doi:10.1111/os.13109

8. Laborie LB, Lehmann TG, Engesæter IØ, Eastwood DM, Engesæter LB, Rosendahl K. Prevalence of radiographic findings thought to be associated with femoroacetabular impingement in a population-based cohort of 2081 healthy young adults. *Radiology*. 2011;260(2):494-502. doi:10.1148/radiol.11102354

9. Direito-Santos B, França G, Nunes J, et al. Acetabular retroversion: Diagnosis and treatment. *EFORT Open Reviews*. 2018;3(11):595-603. doi:10.1302/2058-5241.3.180015

10. Pun S, Kumar D, Lane NE. Review: Femoroacetabular impingement. *Arthritis & Rheumatology*. 2015;67(1):17-27. doi:10.1002/art.38887

11. Sheppard ED, Read CR, Wills BW, Estes AR. Femoroacetabular Impingement in Pediatric Patients. *Pediatrics in Review*. 2019;40(3):129-137. doi:10.1542/pir.2017-0137

12. Zadpoor AA. Etiology of Femoroacetabular Impingement in Athletes: A Review of Recent Findings. *Sports Med*. 2015;45(8):1097-1106. doi:10.1007/s40279-015-0339-2

13. Packer JD, Safran MR. The etiology of primary femoroacetabular impingement: genetics or acquired deformity? *J Hip Preserv Surg*. 2015;2(3):249-257. doi:10.1093/jhps/hnv046

14. Hale RF, Melugin HP, Zhou J, et al. Incidence of Femoroacetabular Impingement and Surgical Management Trends Over Time. *Am J Sports Med*. 2020;49(1):35-41. doi:10.1177/0363546520970914

15. Van Houcke J, Yau WP, Yan CH, et al. Prevalence of radiographic parameters predisposing to femoroacetabular impingement in young asymptomatic Chinese and white subjects. *Journal of Bone and Joint Surgery*. 2015;97(4):310-317. doi:10.2106/jbjs.m.01538

16. Kowalczuk M, Yeung M, Simunovic N, Ayeni OR. Does Femoroacetabular Impingement Contribute to the Development of Hip Osteoarthritis? A Systematic Review. *Sports Medicine and Arthroscopy Review*. 2015;23(4):174-179. doi:10.1097/jsa.0000000000000091

17. Agricola R, Heijboer MP, Ginai AZ, et al. A cam deformity is gradually acquired during skeletal maturation in adolescent and young male soccer players: A prospective study with minimum 2-year follow-up. *Am J Sports Med*. 2014;42(4):798-806. doi:10.1177/0363546514524364

18. Leunig M, Casillas MM, Hamlet M, et al. Slipped capital femoral epiphysis: Early mechanical damage to the acetabular cartilage by a prominent femoral metaphysis. *Acta Orthopaedica Scandinavica*. 2000;71(4):370-375. doi:10.1080/000164700317393367

19. Hosalkar HS, Pandya NK, Bomar JD, Wenger DR. Hip impingement in slipped capital femoral epiphysis: A changing perspective. *Journal of Children's Orthopaedics*. 2012;6(3):161-172. doi:10.1007/s11832-012-0397-z

20. Wenger DR, Kishan S, Pring ME. Impingement and childhood hip disease. *Journal of Pediatric Orthopaedics B*. 2006;15(4):233-243. doi:10.1097/01202412-200607000-00001

21. Weinstein S, Flynn J. Legg-Calvé-Perthes Syndrome. In: *Lovell and Winter's Pediatric Orthopedics*. 7th ed. Lippincott Williams and Wilkins; 2014:1112-1164.

22. Harris-Hayes M, Royer NK. Relationship of acetabular dysplasia and femoroacetabular impingement to hip osteoarthritis: A focused review. *PM&R*. 2011;3(11):1055-1067.e1. doi:10.1016/j.pmrj.2011.08.533

23. Vahedi H, Aalirezaie A, Rolo G, Parvizi J. Hip Dysplasia Compromises the Outcome of Femoroacetabular Impingement Surgery. *Journal of Arthroplasty*. 2019;34(5):852-856. doi:10.1016/j.arth.2019.01.028

24. Accadbled F, Pailhé R, Launay F, Nectoux E, Bonin N, Gicquel P. "Femoroacetabular impingement". Legg-Calve-Perthes disease: From childhood to adulthood. *Orthopaedics & Traumatology: Surgery & Research*. 2014;100(6):647-649. doi:10.1016/j.otsr.2014.03.029

25. Talathi N, LaValva S, Lopez-Garib A, Kelly JD IV, Khoury V. Correlation between femoroacetabular impingement and hamstring tendon pathology on magnetic resonance imaging and arthrography. *Orthopedics*. 2017;40(6):e1086-e1091. doi:10.3928/01477447-20171020-04

26. Kraeutler MJ, Fioravanti MJ, Goodrich JA, et al. Increased Prevalence of Femoroacetabular Impingement in Patients With Proximal Hamstring Tendon Injuries. *Arthroscopy*. 2019;35(5):1396-1402. doi:10.1016/j.arthro.2018.11.037

27. Sankar WN, Nevitt M, Parvizi J, Felson DT, Agricola R, Leunig M. Femoroacetabular impingement: Defining the condition and its role in the pathophysiology of osteoarthritis. *Journal of the American Academy of Orthopaedic Surgeons*. 2013;21(suppl):S7-S15. doi:10.5435/jaaos-21-07-s7

28. Shaw C. Femoroacetabular Impingement Syndrome: A Cause of Hip Pain in Adolescents and Young Adults. *Missouri medicine*. 2017;114(4):299-302.

29. Matar HE, Rajpura A, Board TN. Femoroacetabular impingement in young adults: Assessment and management. *Br J Hosp Med*. 2019;80(10):584-588. doi:10.12968/hmed.2019.80.10.584

30. Griffin DR, Dickenson EJ, O'Donnell J, et al. The Warwick Agreement on femoroacetabular impingement syndrome (FAI syndrome): An international consensus statement. *Br J Sports Med*. 2016;50(19):1169-1176. doi:10.1136/bjsports-2016-096743

31. Ganz R, Parvizi J, Beck M, Leunig M, Nötzli H, Siebenrock KA. Femoroacetabular Impingement: A Cause for Osteoarthritis of the Hip. *Clinical Orthopaedics and Related Research Lippincott Williams and Wilkins*. 2003:112-120. doi:10.1097/01.blo.0000096804.78689.c2

32. Philippon MJ, Maxwell RB, Johnston TL, Schenker M, Briggs KK. Clinical presentation of femoroacetabular impingement. *Knee Surg Sports Traumatol Arthr*. 2007;15(8):1041-1047. doi:10.1007/s00167-007-0348-2

33. Mascarenhas VV, Castro MO, Rego PA, et al. The Lisbon Agreement on Femoroacetabular Impingement Imaging—part 1: overview. *Eur Radiol*. 2020;30(10):5281-5297. doi:10.1007/s00330-020-06822-9

34. Domayer SE, Ziebarth K, Chan J, Bixby S, Mamisch TC, Kim YJ. Femoroacetabular cam-type impingement: Diagnostic sensitivity and specificity of radiographic views compared to radial MRI. *European Journal of Radiology*. 2011;80(3):805-810. doi:10.1016/j.ejrad.2010.10.016

35. Reiman MP, Thorborg K, Goode AP, Cook CE, Weir A, Hölmich P. Diagnostic Accuracy of Imaging Modalities and Injection Techniques for the Diagnosis of Femoroacetabular Impingement/Labral Tear: A Systematic Review with Meta-analysis. *Am J Sports Med*. 2017;45(11):2665-2677. doi:10.1177/0363546516686960

36. Agricola R, Waarsing JH, Thomas GE, et al. Cam impingement: Defining the presence of a cam deformity by the alpha angle. Data from the CHECK cohort and Chingford cohort. *Osteoarthritis and Cartilage*. 2014;22(2):218-225. doi:10.1016/j.joca.2013.11.007

37. Rhee C, Le Francois T, Byrd JWT, Glazebrook M, Wong I. Radiographic diagnosis of pincer-type femoroacetabular impingement: A systematic review. *Orthopaedic Journal of Sports Medicine*. 2017;5(5):232596711770830. doi:10.1177/2325967117708307

38. Pennock AT, Bomar JD, Johnson KP, Randich K, Upasani VV. Nonoperative Management of Femoroacetabular Impingement: A Prospective Study. *Am J Sports Med*. 2018;46(14):3415-3422. doi:10.1177/0363546518804805

39. Minkara AA, Westermann RW, Rosneck J, Lynch TS. Systematic Review and Meta-analysis of Outcomes After Hip Arthroscopy in Femoroacetabular Impingement. *Am J Sports Med*. 2019;47(2):488-500. doi:10.1177/0363546517749475

40. Palmer AJR, Ayyar Gupta V, Fernquest S, et al. Arthroscopic hip surgery compared with physiotherapy and activity modification for the treatment of symptomatic femoroacetabular impingement: Multicentre randomised controlled trial. *BMJ*. 2019;7:l185. doi:10.1136/bmj.l185

41. Hoit G, Whelan DB, Dwyer T, Ajrawat P, Chahal J. Physiotherapy as an Initial Treatment Option for Femoroacetabular Impingement: A Systematic Review of the Literature and Meta-analysis of 5 Randomized Controlled Trials. *Am J Sports Med*. 2020;48(8):2042-2050. doi:10.1177/0363546519882668

42. Casartelli NC, Bizzini M, Maffiuletti NA, et al. Exercise Therapy for the Management of Femoroacetabular Impingement Syndrome: Preliminary Results of Clinical Responsiveness. *Arthritis Care Res*. 2019;71(8):1074-1083. doi:10.1002/acr.23728

43. Philippon M, Bolia I, Locks R, Utsunomiya H. Treatment of Femoroacetabular Impingment: Labrum, Cartilage, Osseous Deformity, and Capsule. *American Journal of Orthopedics*. 2017;46(1):23-27.

44. Peters S, Laing A, Emerson C, et al. Surgical criteria for femoroacetabular impingement syndrome: a scoping review. *Br J Sports Med*. 2017;51(22):1605-1610. doi:10.1136/bjsports-2016-096936

45. Mansell NS, Rhon DI, Meyer J, Slevin JM, Marchant BG. Arthroscopic Surgery or Physical Therapy for Patients With Femoroacetabular Impingement Syndrome: A Randomized Controlled Trial With 2-Year Follow-up. *Am J Sports Med*. 2018;46(6):1306-1314. doi:10.1177/0363546517751912

46. Beck EC, Suppauksorn S, Nho SJ. The Role of Comprehensive Capsular Management in Hip Arthroscopy for the Treatment of Femoroacetabular Impingement Syndrome. *Arthroscopy*. 2020;36(1):9-11. doi:10.1016/j.arthro.2019.10.028

47. Lieberman JR. Hip Arthroscopy for Femoroacetabular Impingement Patients Older Than 50 Years—Proceed With Caution. *Arthroscopy*. 2019;35(9):2759-2760. doi:10.1016/j.arthro.2019.07.002

48. Griffin DR, Dickenson EJ, Wall PDH, et al. Hip arthroscopy versus best conservative care for the treatment of femoroacetabular impingement syndrome (UK FASHIoN): a multicentre randomised controlled trial. *The Lancet*. 2018;391(10136):2225-2235. doi:10.1016/s0140-6736(18)31202-9

49. Ryan M, Toum T, Vigdorchik J. Beyond the Scope Open Treatment of Femoroacetabular Impingement. *Bulletin of the Hospital for Joint Diseases*. 2018;76(1):47-54.

50. Nepple J, Clohisy J. Evolution of Femoroacetabular Impingement Treatment: The ANCHOR Experience. *American Journal of Orthopedics*. 2017;46(1):28-34.

51. Kim HT, Kim UJ, Cho YJ. Anterolateral Approach in the Treatment of Femoroacetabular Impingement of the Hip. *Clin Orthop Surg*. 2019;11(3):337. doi:10.4055/cios.2019.11.3.337

52. Wu CT, Mahameed M, Lin PC, Lu YD, Kuo FC, Lee MS. Treatment of cam-type femoroacetabular impingement using anterolateral mini-open and arthroscopic osteochondroplasty. *J Orthop Surg Res*. 2019;14(1). doi:10.1186/s13018-019-1257-z